Origin of Photovoltaic Effect in Metallic Photonic Crystal Slabs

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We report photo-induced voltage across metallic photonic crystal slabs. The effect is ascribed to the photo-rectification effect based on the second-order electromagnetic terms in the equation of motion for carriers. One-dimensional line-and-space resist patterns (1x1 mm^2, typical period of 850 nm) are located on Au or Cr semi-transparent thin film strip. The electric field distribution in the metal is much simpler compared to our previous experiments on engraved metallic gratings, which allows us to make quantitative comparison between the experiment and theory. A collimated P-polarized tunable laser beam (wavelength 800-1000 nm, pulse width 7 ns, typical pulse energy 10 μJ) is incident on the pattern at various angles. Polarization is perpendicular to the grating grooves. The amplitude (typically mV) and sign of the voltage is sensitively dependent on the wavelength and incident angle. With the scattering matrix calculation we analyze the electromagnetic field distribution in the metal, from which the photo-induced voltage is estimated. Finally similar measurements on the prism-coupled metallic thin film system will be compared to those on metallic photonic crystals.